No. 304 OCTOBER 2011

T.W.I.T.T. NEWSLETTER

1959 Fauvel A.V.22.S landing during the Vintage Rally in Osoppo, Italy. For more on the Fauvel see page 3.

T.W.I.T.T.
The Wing Is The Thing
P.O. Box 20430
El Cajon, CA 92021

The number after your name indicates the ending year and month of your current subscription, i.e., **1110** means this is your last issue unless renewed.

Next TWITT meeting: Saturday, November 19, 2011, beginning at 1:30 pm at hanger A-4, Gillespie Field, El Cajon, CA (first hanger row at 1720 Joe Crosson Drive – Southeast side of Gillespie).

THE WING IS THE THING (T.W.I.T.T.)

T.W.I.T.T. is a non-profit organization whose membership seeks to promote the research and development of flying wings and other tailless aircraft by providing a forum for the exchange of ideas and experiences on an international basis. T.W.I.T.T. is affiliated with The Hunsaker Foundation, which is dedicated to furthering education and research in a variety of disciplines.

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Members only section: ID – **20issues10**
Password – **twittmbr**

Subscription Rates: $20 per year (US)
$30 per year (Foreign)
$23 per year US electronic
$33 per year foreign electronic

Information Packages: $3.00 ($4 foreign)
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Multiple Back Issues of the newsletter:
$1.00 ea + bulk postage

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Meetings are held on the third Saturday of every other month (beginning with January), at 1:30 PM, at Hanger A-4, Gillespie Field, El Cajon, California (first row of hangers on the south end of Joe Crosson Drive (#1720), east side of Gillespie or Skid Row for those flying in).

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PRESIDENT'S CORNER

I have what I think is an excellent issue for you this month thanks to two members making great contributions. My thanks to both, but my apologies to those of you who also get Sailplane Builder for the duplication.

Murry Rozansky's article Walking the Plank originated from his presentation at the 2011 ESA Western Workshop over Labor Day weekend at Tehachapi, CA. This is just an example of the type of presentations that are given for two straight days at this event as was the Hummingbird talk by the guys from Aerovironment. So pull out your 2012 calendar and mark Labor Day weekend for your trip to Tehachapi and join in on this unique learning experience.

If you live on the east coast there is the ESA Eastern Workshop being held October 7-9 at Massey Air Museum, Maryland, along with the Vintage Sailplane Association's regatta.

James McLellan's description of a computer program that will help you with design work fills out the rest of this issue.

I much prefer putting together an issue like this one with good information for our members rather than just copying what I can from the Nurflugel and Mitchell U-2 threads that come in each month. Don't get me wrong since there is also a lot of good information in these threads, but it is so much better to have articles with great information and illustrations or photos that you can sink your teeth into. I know a lot of you really like the images and I am always happy to have them, especially when they are directly related on one of your projects.

Andy

LETTERS TO THE EDITOR

September 7, 2011

Andy,

A friend sent me the website for viewing Al Bowers talk. (The same one he gave Sunday at the ESA Western Workshop). Thought it would be worth mentioning in the newsletter since it directly affects the design of flying wings.

It is also completely consistent with my findings associated with soaring bird models WITHOUT vertical tails.

http://www.youtube.com/user/TEDxNASA#p/c/4/223OmaQ9uLY

Bob Hoey
<bobh@antelecom.net>

(ed. – Al indicated he had to get his TED talk down to 6-8 minutes, but fortunately he had much more time at the workshop to cover his thoughts in more detail. I think I will have more in a coming issue on his talk so those of you without an Internet connection will be able to read about his presentation.)

September 11, 2011

I went to Italy to attend a Vintage Rally sponsored by Vincenzo Pedrielli, a good friend of ours from Milan. The Rally was in Osoppo, Italy and was attended by 15 gliders and about 45 people from around Europe, with visitors also from Japan and the USA. One of the gliders attending was a 1959 Fauvel A.V.22.S, brought to the Rally by Christian Mathieu from Northeast France.

To see info on the Osoppo rally go to:

http://www.vincenzopedrielli.it/osoppo11foto_eng.html

I was able to make a 2.5 hour flight with Christian. We released from a 600-meter tow and climbed to 2300 meters over the mountains. The glider flies fine with the following features:

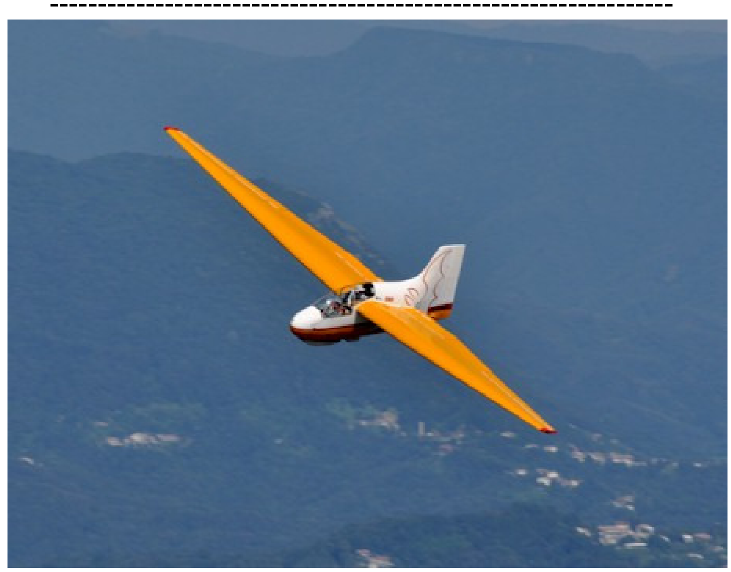
1. The glider is BIG.
2. Rear seat visibility is excellent due to the rear seat being a foot higher than the front.
3. Elevator forces and pitch stability are very normal
4. Yaw stability is low but yaw inertia is high
5. The rudder is very powerful. With the low yaw stability and high inertia it is easy to fly sideways. You must stay on the rudder all the time-but it is not a problem.
6. The CG range is narrow (sorry I am not sure what it is, but they check the weight of each passenger). Due to the narrow margin, a significant speed change can be made by leaning forward in the cockpit. This is how Christian made all speed changes once the trim was set after release. When you want to go 30 km/h faster, just lean forward.
7. Roll is normal for a big old glider (think 2-33)
8. The dive brakes are interconnected with the elevator trim to help reduce pitch changes with dive brake actuation.
9. The main wheel is very far forward (tail dragger) and it is very easy to pitch up on landing.

I have attached a number of pictures and there are more on Vincenzo's website. Let me know if you have any questions!

Regards;

Doug Fronius

(ed. – I had asked Doug for some pictures of the Fauvel for the newsletter and in the mean time he also had a request for more information on it from Murry Rozansky. So it made a good addition to just the photos to have his impressions of the ship.)



Above: Doug and Christian before their flight. Notice the black square on the fuselage about knee high on Christian. This is a footstep getting into the glider since the cockpit sill is so high.

Below: High over the mountains during their flight. This also gives you an idea of the excellent visibility from both seats.

September 28, 2011

Over the years I have seen a number of references to the Stanford 'wingcalc' program available for use on the internet. There seems to be an understanding that you can get tailor a wing to get a desired lift distribution and local lift coefficient distribution from the program for a given wing lift coefficient. Some sites that reference 'wingcalc' have also noticed that it gives an induced drag efficiency 'e' (higher value means less induced drag). What seems to be missed is that 'wingcalc' can also be used to determine the aerodynamic center of the wing and to determine where the c.g. should be placed to get flight at a given lift coefficient without control surface deflection. I've attached a Word document with a description of how to determine the c.g. location for a given lift coefficient and the aerodynamic center of the wing. I've checked the results against calculations I did a few years ago using the data from Abbott and Von Doenhoff and found that the methods agree, . . . using 'wingcalc' data was much easier.

I also attached a picture of a Red Tail Hawk and Red Wing Blackbird that someone sent me in an email. It is a nice picture of the tip feathers on the hawk.

Have fun,

James McLellan
<jwmcl@q.com>

(ed. – I thought Murry's article was going to need two issues but the full thing ended up leaving me room in this issue and James' e-mail with attachment was very timely in terms of having some material other than Nurflugel and U-2 threads. You can read about 'wingcalc' later in this issue. Red Tailed hawk below.)

Walking the Plank

Murry I. Rozansky
Experimental Soaring Association
Western Workshop 2011

Is it possible for a person of limited means to soar like the eagles? We are still asking that question more than 50 years after our late member, Al Backstrom shook up soaring and flying in general with his Flying Plank. The Plank was an attempt to design the smallest, easiest to build sailplane. That is still a worthy goal today.

Al did not invent the self-stabilized straight flying wing. That honor should go to a man ahead of his time, Alphonse Penaud. His two place amphibious flying wing was patented in 1876.

The next major pioneer was Rene Arnoux, also French, who built a plank type aircraft before WW I.

He was followed, between the wars, by Charles Fauvel, the most successful straight flying wing designer, also French. Unlike the others, Charles was a soaring enthusiast and many of his design were sailplanes or motor gliders. His work continued and became better known after WWII. Some of his designs were factory built and many were built from plans. Our own Jack Lambie flew one and wrote about it in Soaring.

Fauvel's designs were a major influence on Al Backstrom and our member, Jim Marske, as we shall see.

Now that we have a little background we need to answer the big Question, "Why a Plank?"

The expressions, "Less is more" and "Simplicate and Add Lightness" pretty well capture the appeal. If it can be designed to fly well and safely, the plank or modified plank configuration should be the easiest and least expensive way to build a sailplane.

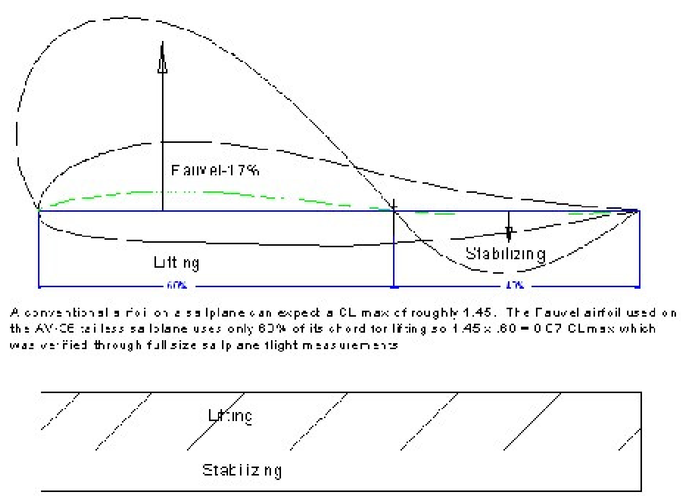
The existence of reasonably priced used sailplanes, both factory and amateur built has greatly reduced the homebuilding of sailplanes. The sailplane that I would like to have is not available at reasonable cost new or used. That is why I am looking at walking the plank. Is it the right configuration to meet my requirements?

What I am looking for is:

- A motor equipped sailplane that can reliably operate from conventional airports.
- 30:1 max L/D or better with good climbing ability in normal to strong soaring conditions. A micro lift glider is not in the cards.
- Pleasant and safe handling qualities.
- Easy and rapid to build of affordable materials in a limited space.
- Can fit in a compact trailer.

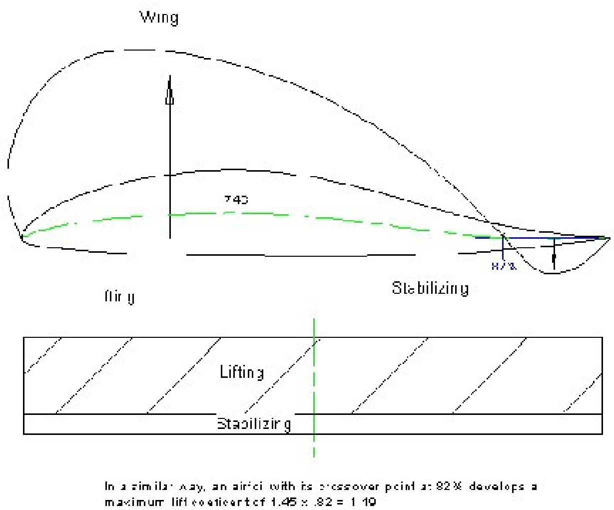
We are not asking for much, are we? Can a plank work and help meet these difficult requirements?

People more easily accept that a swept flying wing (another subject) can be stable than a straight one. They are used to seeing a stabilizing surface sticking out at the back on a stick. In a straight flying wing the stabilizing area is incorporated into the trailing edge of the wing by reflexing the camber line of the airfoil. Jim Marske's drawing will make it clear. An implication of this is the need for additional wing area in the flying wing. Which has lower total wetted area, the wing or conventional configuration?



(Image text reads: A conventional airfoil on a sailplane can expect a CLmax of roughly 1.45. The Fauvel airfoil used on the AV-36 tailless sailplane uses

only 60% of its chord for lifting so 1.45 x .60 = 0.87 CLmax which was verified through full size sailplane flight measurements.)



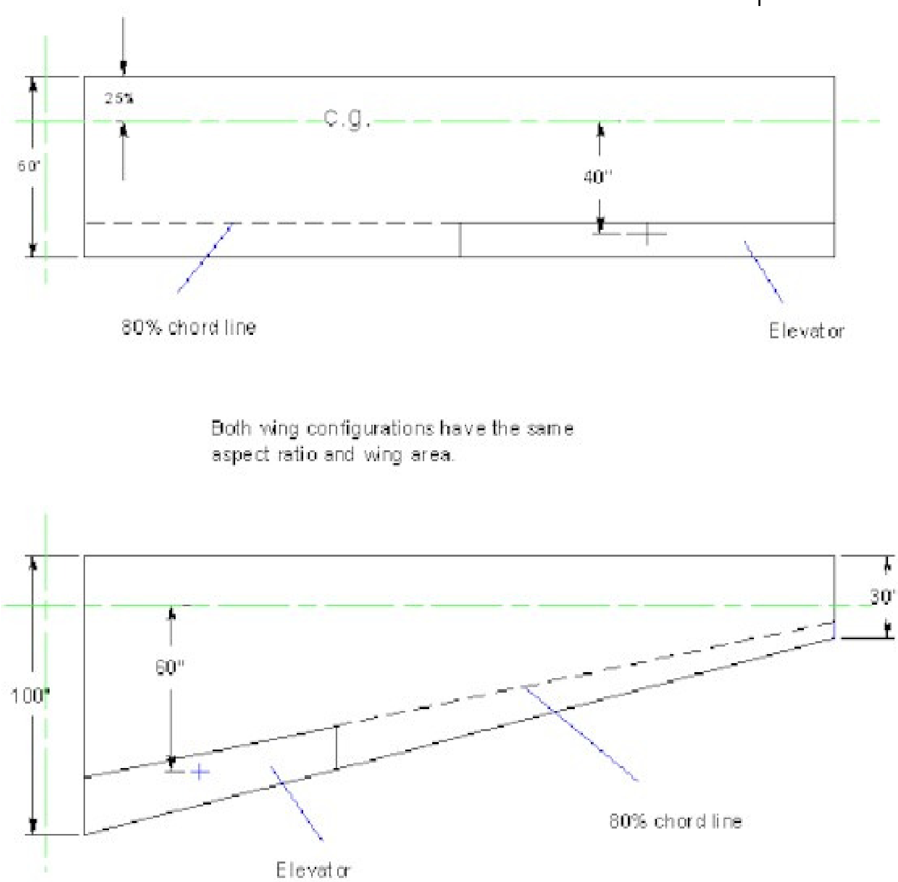
(Image text reads: In a similar way, an airfoil with its crossover point at 82% develops a maximum lift coefficient of 1.45 x .82 = 1.19.)

After his initial plank experiments, Jim has adopted what he calls a reverse delta configuration; a straight or slightly swept forward leading edge with a large amount of taper. His drawing makes some of the advantages clear but it eliminates the building advantages of the constant chord wing.

Can the best features of Fauvel, Backstrom and Marske be combined with a little John Roncz throw in be combined with an efficient building method to produce the glider of my dreams. This is where my "paper" plank stands today.

First we look at the pod. Here is where everything that is not wing goes. Where flying wings really shine is in very large aircraft where almost everything can be put inside the wing.

- We have the relatively gross pilot to streamline. Let's say 250# wet with chute.
- An engine with drive line and a folding or feathering prop. A four stroke for reliability and 25-35 hp, 100#.
- The pod, landing gear, fuel and tank, 100#.
- That is 450# on the centerline of which 280# are useful load.



(Accompanying Text reads: Another popular opinion often heard is that since the elevator is part of the wing, pulling back on the stick raises the elevator which further reduces the overall wings lift coefficient when it is most desired. This is very true on rectangular, Hersey Bar, shaped wing configuration. Due to the short moment arm between the elevator and the c.g., leverage is gained through generous elevator area and elevator upwards deflection.

However, when the wing is highly tapered, like 3 or 4 to 1, this effect can be highly diminished. Below is a comparison between the two configurations. Note the increase in moment arms and decrease in required elevator area.

The stabilizer area of the rectangular wing counters the efforts of the elevator portion making the elevator 50% effective. The taper wing elevator over powers the efforts of the stabilizing portion due to the difference in moment arms.)

These are ballpark numbers and a pretty much independent of the size and span of the wing that supports it. If we get really big we would need more engine and fuel and would be climbing the dreaded weight spiral. Because of the power plant and extra weight of the landing gear for airport operation and prop clearance, I think 15 m. should be the minimum target for performance. By looking at the wing weights of other 15 m. ships, 300# wing weight is a good guess. So where are we now?

- 750# gross weight with 280# of useful load including 30# fuel.
- 470# empty weight, 300# wing weight.
- Because of the extra engine weight we have to accept a bit higher wing loading than Al and Jim would recommend and go for 5#/sq. ft.: 150 sq. ft. and 3 ft. MAC.

Before talking about wing construction I should explain some of the design decisions. One of the basic ones is to go for the lowest weight or the lowest drag. Without going to expensive tooling and materials the lightest way to build sailplane wings for the homebuilder seems to be updated plywood D-tube and cloth covering. The use of epoxy and carbon pultrusions has brought wood into the 21st century. Wood construction is light but labor intensive, weather sensitive and is difficult to achieve laminar, low drag surfaces.

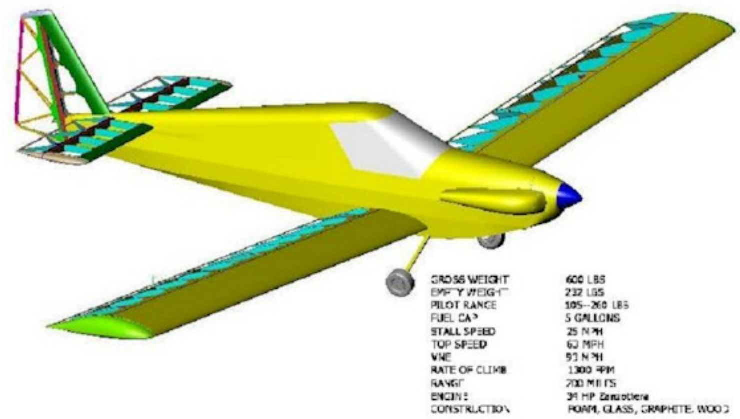
Having an engine as a crutch, the need to be a real floater is lessened. Johnny Robinson related to me some time back how he flew his Fornier motor glider. It did not have an electric starter and he had no interest in out landings when flying for fun so he would pull the engine back to idle while soaring. "What ever L/D or sink rate you want is a twist of the vernier away." I came across an article that stated Johnny was one of Al Backstrom's instructors.

So our paper plank wants to have laminar, most likely composite wings. The pod might be best made of steel tubing with a smooth composite outer skin. A great help for this and other potential sailplane projects would be a fiberglass pod shell, canopy frame and transparency for a reasonable price.

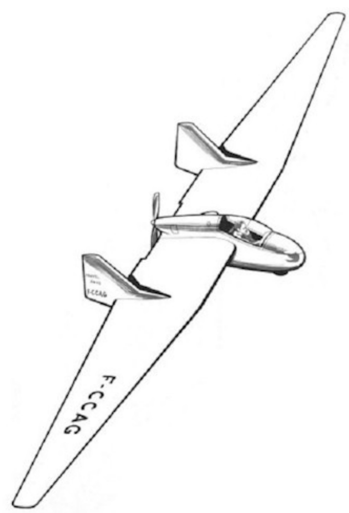
Can a homebuilder build a laminar sailplane wing at 2# per sq. ft. or less? That is a question.

It is fascinating to see the chain of consequences of seemingly simple design decisions. One of them is push or pull. The conventional tractor type motor glider like the Fornier and the ultralight Robin *(left)* have the simpler engine installation.

The pusher installation looks like it would have lower drag but it does not always turn out that way. It is much easier for air to get out of the way of a blunt nose than to come back together smoothly past a big butt. It is called base drag. To minimize it, unless the engine has a small cross section, takes an extension or shaft drive. Cooling a mid or aft mounted engine is more difficult. The pusher is going to be heavier and more complex. Is it worth it for what is largely an esthetic consideration? One of the initial attractions to the plank was the elimination of the need for a boom(s) to support tail surface clear of the prop disc.



With the proper choice of airfoil we can achieve pitch stability. Directional stability is a challenge without the help of that marvelous Stone Age invention, the lever or tail boom. Al and Jim's early planks started out with tip mounted vertical surfaces with drag rudders. With their short span the endplate effect was thought useful. They were pre winglets. The tip fins did not work very well and both planks went to central fins. Tip mounted verticals seem to work well on swept flying wing as was established by Dr. Lippisch in the 1920s. The sweep back gives them some lever arm to increase their effectiveness. With a straight wing, the yawed forward tip vertical's lift vector gets closer to the CG, reducing its effectiveness. Some of Fauvel's designs used twin verticals mounted on the wing center section and a bit farther back than would be practical on the tips. Putting the prop at the back of the pod then becomes the natural thing to do.



Building and trailering considerations require break points in the structure. They are not desirable in terms of increased weight and cost and building time, but are necessary. The logical place for the verticals is at the spar joint of a fixed center section. Trailering and prop clearance put the verticals 7 to 8 ft apart. Some things are starting to be defined.

The early planks used elevons for pitch and roll which make it difficult to deal with adverse yaw. Jim's change in plan form and separate elevator and ailerons deals with that problem. Separate surfaces can be used on a plank. Another problem with trailing edge pitch control surfaces is the flap effect. When the elevator is moved trailing edge up to increase the AOA of the wing, the flap effect decreases the local lift before the inertia of the aircraft allows the aircraft to pitch up. This reduces efficiency and could lead to hard landings. A plus for elevons is at high angles of attack the wing is effectively washed out, reducing the chance of tip stall and if not excessive, might slightly improve the lift distribution.

A way to eliminate the flap effect is to remove the pitch control from the wing as is done in Jeff's Genesis. I am not sure if it was Jim Marske's or John Roncz's idea. What looks like a T tail is an external elevator. It is not there to stabilize the aircraft. It is the pitch control. Having some increase in lever arm and its own leading edge makes the external elevator an effective pitch control with a modest amount of drag while eliminating the flap effect. You see where this leads. We put our external elevator between the tops of our twin fins.

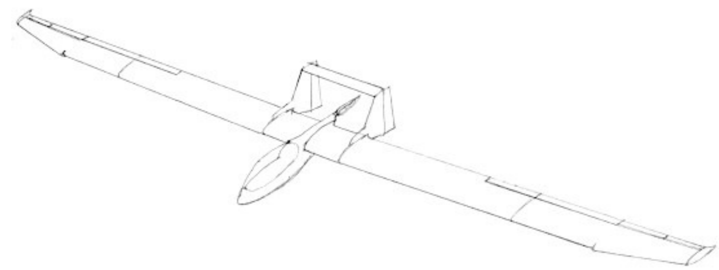
You might also ask, "Why not mount your tails farther back on booms and make it a conventional twin boom pusher?" Good question. You have to answer it for yourself. If I was committed to using a powerful flap system, a single low mounted tail boom would be a more efficient design if esthetically inferior to the twin boom.

We have the center section pretty well defined. As we are talking about a plank, is it worth tapering the outer 20% or so of the semi span as Alex Stojnick suggested? Will it improve performance and roll response enough to be worth the extra building effort? It would look better.

Ailerons for roll control can be used with differential to minimize adverse yaw as pitch up can be canceled by the external elevator. Sailplanes need a lot of yaw control power. Our planks verticals are there to counter balance the pod sticking forward of the wing. Without excessively large and draggy verticals the twin rudders are going to need some help. The long lever arm of the semi span aggravates and is also the solution to the problem of yaw control power. Drag rudders near the tips have been used in many flying wing designs. The outer ends of the ailerons can be split to be used as drag rudders. When Jim tried drag rudders right at the tip of his plank, they did not work very well. He was near giving up until he tried Al's suggestion of adding some wing tip extensions to get the drag rudders out of the tip vortex.

Flying wings like to have their CG closer to the neutral point than conventional configurations. It minimizes trim drag and makes a movable weight trim system possible. It also makes an accurate weight and balance before each flight safety critical. It also means that pitch changes with power, or when being towed, or using glide path control needs to be minimized. I am not a fan of cutting holes in the middle of a laminar wing for conventional spoilers. I would favor split flaps inboard of the ailerons or maybe split rudders on the verticals.

That pretty much describes what I think a plankoid should look like at this point.



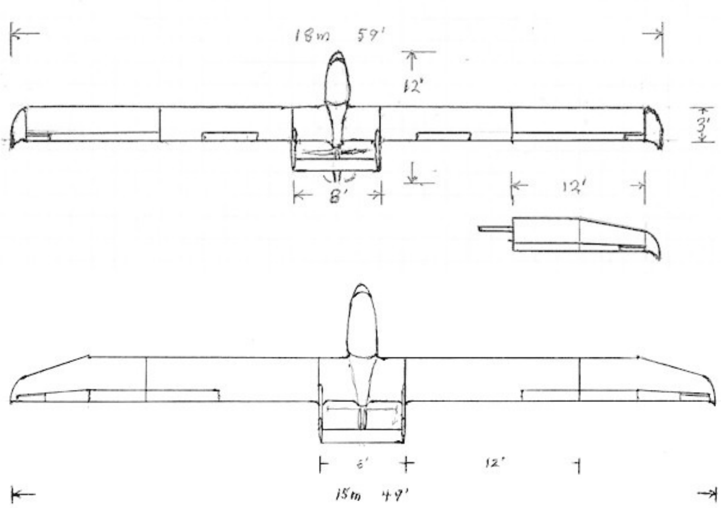
How does a homebuilder construct a large lightweight laminar flow wing? One of the bits of magic is the use of vacuum and atmospheric pressure to minimize resin content and manual labor in the fiberglass work. Vacuum Infusion involves laying dry reinforcement in or on the mold, placing some additional materials, typically peel ply and vacuum and resin feed tubes on top. The whole sandwich is covered with bagging material that is sealed to the mold perimeter and around any tubes through the bag. Vacuum is pulled and the bag is checked for leaks and the air is pulled out. The feed tube from the resin bucket is opened and the resin infuses the reinforcing material. Done properly, 70% fiber volume is possible with lower void content than with prepreg. Both sides of a sandwich can be infused at one shot.

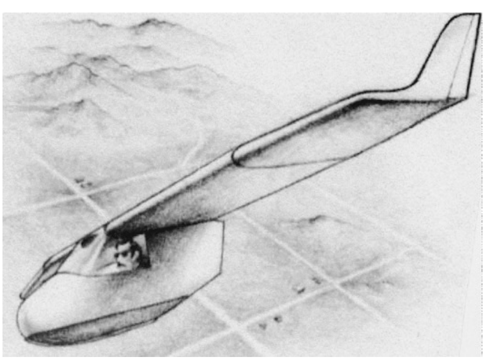
The base for molding is a flat table. 4ft. X 16 ft. can be made from standard sheet materials and should fit in most work areas. The surface needs to be smooth, flat and air tight. A 15 ft. long spar could be laid up on the table. That would include the stub for the wing joints. The spar mould would be two aluminum angles clamped to the table and fillet wax for the inside corner radius. Sandwich ribs and bulkheads can be infused flat and routed or water jet cut to shape. Peel ply should be used to reduce bonding prep time.

"Moldless Composite Homebuilt Sandwich Aircraft Construction", pioneered by Burt Rutan is a proven technique. The down side of it is the man-years of filling and sanding needed to get really good surfaces. That type of finishing also adds weight. The combination of hotwired cores and vacuum infused skins has potential to greatly reduce finishing labor. After we try some ideas we will have more to talk about. With hotwired cores, taper is easy.

Another possible technique for the constant chord sections is to hot wire and finish, say a 4ft section of wing airfoil as a master pattern for fabricating top and bottom wing skin molds. Sandwich ribs with broad cap strips for joining the wing panels would be bonded to the spars that were bag molded on the table.

With an eight-foot center section and two twelve-foot outer panels you notice we are short at 32 feet. Well making wing panel is now so easy; add another pair for 24 more feet for 56 feet of span, with tips, an 18-meter span and it will fit on a 16-foot trailer. If you are going to add weight to a sailplane add span.





Al Backstrom's idea of a very small plank.

Where Should the C.G. Be? Where is the Aerodynamic Center?

These seem to be a common questions for tailless aircraft. If your wing has a linear taper and twist these question may be answered using a simple program available on the internet.

http://aero.stanford.edu/wingcalc.html

Wing Analysis Program

This Java application computes the lift and Cl distribution over a wing with sweep and twist.
To increase the angle of attack, click near the upper part of the plot; to reduce alpha, click in the lower area.

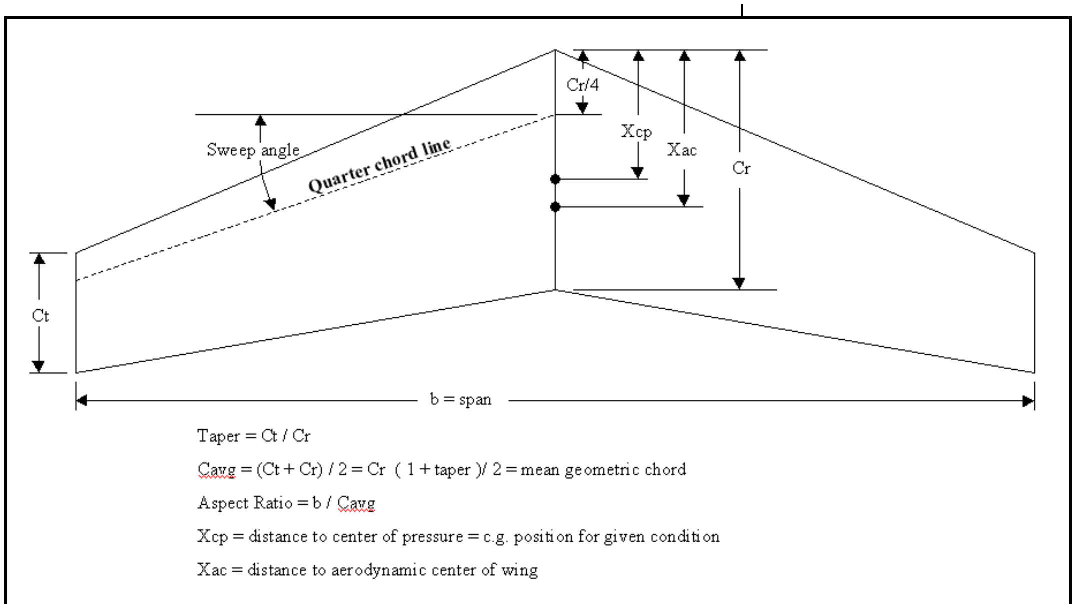
Details:

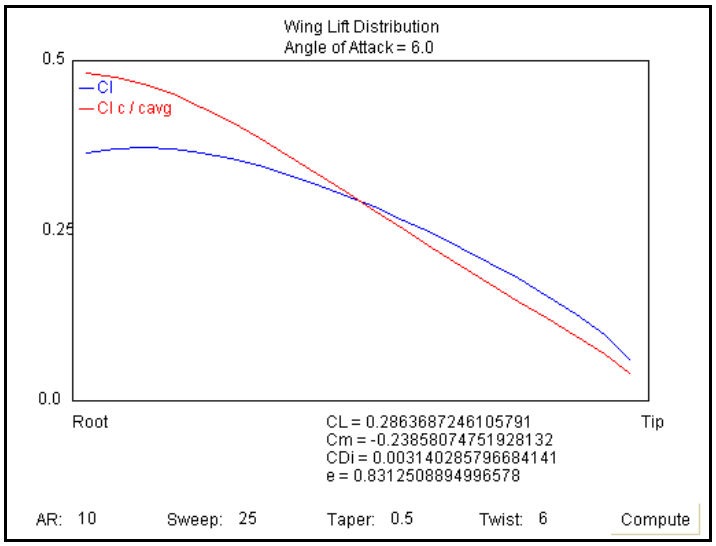
The analysis is a discrete vortex Weissinger computation. Pitching moment is based on the mean geometric chord and is measured about the root quarter chord point. The twist is assumed linear and is taken to be positive for washout (tip incidence less than root incidence).

The program is linear so it will not predict stall or correctly predict behavior outside the range where your airfoil lift curve slope, (dCl / dalpha), is linear. It may be used to predict which part of the wing will stall first by looking at where the peak Cl is when its value is approaching the value at stall.

The picture on the next page provides some geometric labels. Wingcalc.html provides moment about the root quarter chord point. For ease of use the center of pressure location, Xcp, and aerodynamic center location, Xac, will be calculated from root leading edge.

The picture on the next page is a screen capture from wingcalc.html. The geometric input is shown on the line at the bottom, the angle of attack is shown at the top, and aerodynamic coefficients are listed right below the plot. One line shows local lift coefficient, Cl, at different locations between the root and tip section. The other line shows the lift distribution, Cl*c/cavg.





Input value explanation:

AR = Aspect Ratio = b^2 / S : where: b = wingspan, and S = wing area

Sweep = angle of 1/4 chord line relative to a line perpendicular to the plane of symmetry

Taper = tip chord / root chord = ct /cr

Twist = washout of tip relative to root in degrees

Angle of attack, alpha, is the angle of the zero lift line of the root chord relative to the free stream. It is increased by clicking the mouse near the top of the plot or decreased by clicking near the bottom of the plot.

Output:

The plot shows the local lift coefficient, Cl, and the wing loading as Cl (c/cavg). The table below the plot shows:

Cl = wing lift coefficient for the geometry and angle of attack you chose

Cm = moment coefficient based on the mean geometric chord and measured about the root 1/4 chord point.

Cdi = induced drag coefficient

e = indication of induced drag efficiency, Cdi = Cl^2/ (e 3.1416 AR)

A higher 'e' means less induced drag. 'e' should equal 1.0 for an elliptic lift distribution.

cavg = cr (1+ taper)/2 = average chord in terms of the root chord = mean geometric chord in terms of root chord

With results at one angle of attack you can calculate where the c.g. should be.

Assume that the airfoil pitching moment coefficient about the airfoil aerodynamic center, Cmaf, is constant over the span. This is true if you use the same airfoil section for the whole wing or if you choose your sections with constant Cmaf as a goal. For ease of locating I have worked this out to be the distance from the leading edge of the root chord.

Xcp = center of pressure position measured from LE of the root chord

= -((Cm+Cmaf)/ Cl) cavg + cr/4

= [-((Cm+Cmaf)/ Cl) (1+ taper)/2 + 1/4] cr

example: using the data from the previous plot

alpha	Cl	Cm
6.	.2864	-.2386

If you use an airfoil with Cmaf = 0.0 then:

Xcp = [-((-.2386+ 0.0)/ .2864) (1+.5)/2 + 1/4] cr = .875 cr

So the center of pressure, Xcp, of this geometry flying at this lift coefficient is 87.5% of the root chord length behind the leading edge of the root chord. This is where you would want the c.g. to be if you wanted to fly at this lift coefficient with no control surface deflection.

If you use an airfoil with Cmaf = -.05 then:

Xcp = [-((-.2386 -.05)/ .2864) (1+.5)/2 + 1/4] cr = 1.006 cr

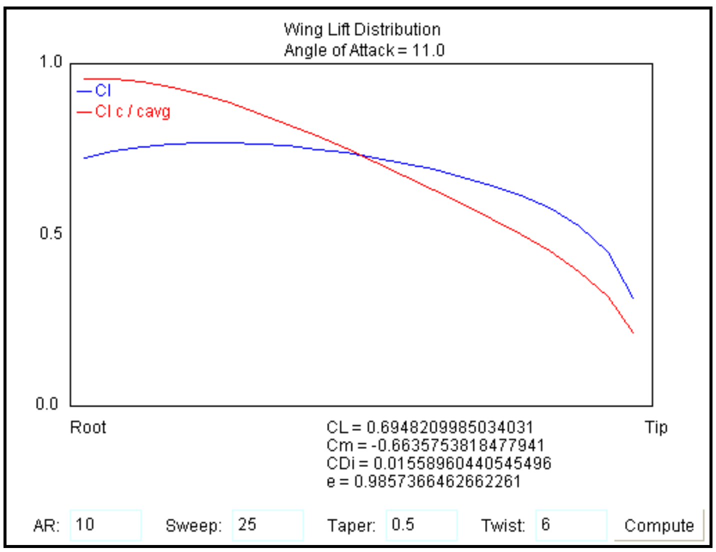
So the center of pressure of this geometry flying at this lift coefficient is 100.6% of the root chord length behind the leading edge of the root chord. This shows that using an airfoil with a nose down pitching moment moves the center of pressure aft.

If you use a reflexed airfoil with Cmaf = +.05 then:
Xcp = [-((-.2386 +.05)/ .2864) (1+.5)/2 + 1/4] cr = .744 cr

So the center of pressure of this geometry flying at this lift coefficient is 74.4% of the root chord length behind the leading edge of the root chord. This shows that using an airfoil with a nose up pitching moves the center of pressure forward.

<u>With results at 2 different angles of attack you can calculate the aerodynamic center position</u>.
The aerodynamic center position aft of the leading edge of the root airfoil is :

Xac = cavg (-dCm/dalpha)/ (dCl/dalpha) + cr/4
= [cr (1 + taper)/2] (-dCm/ Cl) + cr/4



<u>example</u>: using the data from the previous plot

	alpha	Cl	Cm
1	6.	.2864	-.2386
2	11.	.6948	-.6636
(2 - 1) =	5.	.4084	-.4250

dCl = .4084, dCm = -.4250

Xac = [cr (1 + taper)/2] (-dCm/ Cl) = [cr (1 + .5)/2] (.4250/ .4084) + cr/4 = 1.031 cr

So the aerodynamic center of this geometry is 103.1% of the root chord length behind the leading edge of the root chord. Adding an airfoil moment coefficient will not change this answer as long as the same moment coefficient is used over the whole span.

You will calculate the same aerodynamic center position regardless of which two angle of attack results you use since the program is linear. I'd suggest using values from angles of attack that are more than 5.degrees apart so that dCl and dCm are not too small.

Aerodynamic center position is not changed by airfoil moment coefficient as long as the coefficient is the same at all points along the span. This is satisfied if you use the same airfoil section at all points on the wing.

AVAILABLE PLANS & REFERENCE MATERIAL

Coming Soon: <u>Tailless Aircraft Bibliography</u>
Edition 1-g

Edition 1-f, which is sold out, contained over 5600 annotated tailless aircraft and related listings: reports, papers, books, articles, patents, etc. of 1867 - present, listed chronologically and supported by introductory material, 3 Appendices, and other helpful information. Historical overview. Information on sources, location and acquisition of material. Alphabetical listing of 370 creators of tailless and related aircraft, including dates and configurations. More. Only a limited number printed. Not cross referenced: 342 pages. It was spiral bound in plain black vinyl. By far the largest ever of its kind - a unique source of hardcore information.

But don't despair, Edition 1-g is in the works and will be bigger and better than ever. It will also include a very extensive listing of the relevant U.S. patents, which may be the most comprehensive one ever put together. A publication date has not been set yet, so check back here once in a while.

Prices: To Be Announced

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Books by Bruce Carmichael:
Personal Aircraft Drag Reduction: $30 pp + $17 postage outside USA: Low drag R&D history, laminar aircraft design, 300 mph on 100 hp.
Ultralight & Light Self Launching Sailplanes: $20 pp: 23 ultralights, 16 lights, 18 sustainer engines, 56 self launch engines, history, safety, prop drag reduction, performance.
Collected Sailplane Articles & Soaring Mishaps: $30 pp: 72 articles incl. 6 misadventures, future predictions, ULSP, dynamic soaring, 20 years SHA workshop.
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VIDEOS AND AUDIO TAPES

(ed. – These videos are also now available on DVD, at the buyer's choice.)

VHS tape containing First Flights "Flying Wings," Discovery Channel's The Wing Will Fly, and ME-163, SWIFT flight footage, Paragliding, and other miscellaneous items (approximately 3½+ hours of material).
Cost: $8.00 postage paid
Add: $2.00 for foreign postage

VHS tape of Al Bowers' September 19, 1998 presentation on "The Horten H X Series: Ultra Light Flying Wing Sailplanes." The package includes Al's 20 pages of slides so you won't have to squint at the TV screen trying to read what he is explaining. This was an excellent presentation covering Horten history and an analysis of bell and elliptical lift distributions.

Cost: $10.00 postage paid
Add: $ 2.00 for foreign postage

VHS tape of July 15, 2000 presentation by Stefanie Brochocki on the design history of the BKB-1 (Brochocki,Kasper,Bodek) as related by her father Stefan. The second part of this program was conducted by Henry Jex on the design and flights of the radio controlled Quetzalcoatlus northropi (pterodactyl) used in the Smithsonian IMAX film. This was an Aerovironment project led by Dr. Paul MacCready.

Cost: $8.00 postage paid
Add: $2.00 for foreign postage

An Overview of Composite Design Properties, by Alex Kozloff, as presented at the TWITT Meeting 3/19/94. Includes pamphlet of charts and graphs on composite characteristics, and audio cassette tape of Alex's presentation explaining the material.

Cost: $5.00 postage paid
Add: $1.50 for foreign postage

VHS of Paul MacCready's presentation on March 21,1998, covering his experiences with flying wings and how flying wings occur in nature. Tape includes Aerovironment's "Doing More With Much Less", and the presentations by Rudy Opitz, Dez George-Falvy and Jim Marske at the 1997 Flying Wing Symposiums at Harris Hill, plus some other miscellaneous "stuff".

Cost: $8.00 postage paid in US
Add: $2.00 for foreign postage

VHS of Robert Hoey's presentation on November 20, 1999, covering his group's experimentation with radio controlled bird models being used to explore the control and performance parameters of birds. Tape comes with a complete set of the overhead slides used in the presentation.

Cost : $10.00 postage paid in US
$15.00 foreign orders

FLYING WING SALES

BLUEPRINTS – Available for the Mitchell Wing Model U-2 Superwing Experimental motor glider and the B-10 Ultralight motor glider. These two aircraft were designed by Don Mitchell and are considered by many to be the finest flying wing airplanes available. The complete drawings, which include instructions, constructions photos and a flight manual cost $250 US delivery, $280 foreign delivery, postage paid.

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(ed. – These images came for Murry's PowerPoint presentation at the ESA Western Workshop.)

Above: Reg Todhunter's side-by-side flying wing sailplane.

Above: Jim Marske ready to make the first test flights of his Pioneer 3, which were successful.

Below: Mike Hostage's Modified Marske Pioneer II. Good comparison with Jim's P-III.